INSTITUTE OF PETROLEUM REVIEW

Published by The Institute of Petroleum
26 Portland Place, London, W.1

JUL 24 1948
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Volume 2. No. 18. June, 1948. Price 2/-. Annual Subscription: One Guinea

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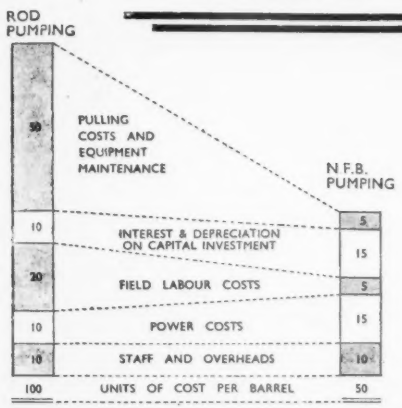

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No. 18 JUNE, 1948 Vol. 2

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PETROLEUM IN THE MODERN WORLD*

By J. A. ORIEL, C.B.E., M.C. (*Vice-President*)

THIS talk at the opening of a branch seemed to me to be a suitable opportunity for reviewing the present position of the petroleum industry as far as my limited knowledge would allow. The actual subject of my lecture was chosen after some discussion and finally "Petroleum in the Modern World" was decided on. By "modern" I mean during the last three or four decades, and I should like to deal to some extent with the development of the industry within that period, without touching the earlier history of petroleum, which indeed extends back into prehistoric times. It is during this period of the last 30 or 40 years that our industry has expanded with almost unbelievable speed, alongside the simultaneous development of the internal combustion engine.

It is a very interesting reflection to note that neither the internal combustion engine nor the petroleum products are saleable by themselves. I should like you to ponder over this fact because then as you realize how true it is, it will bring out clearly how closely the developments of the internal combustion engine are tied up with the developments in our industry.

It is true to say that the development of petroleum and the development of the internal combustion engine have gone hand in hand from their birth, which one might almost say was about 50 years ago. We can confine our talk to developments in a much shorter period than that, even to the last 25 years, because before the 1914–18 war development had not gone very far.

* Address delivered at Inaugural Meeting of London Branch, Institute of Petroleum, March 4, 1948.

The seeds had been sown, the first aeroplane had been flown, but it was during the 1914–18 war that motor transport and aerial activity really developed.

There is I think no need to remind you that, in the very earliest days, the only use for petroleum products was for the lighting kerosine which replaced the older vegetable oils. It is well within living memory that the gasoline fractions were burned as waste. I will, however, move straight over to the period round about the First World War.

Motor Fuel

During the years immediately prior to 1914 the first chemical investigation into the desiderata for a good gasoline was made by Professor H. O. Jones and by Mr (now Sir Harry) Ricardo. It is probably fair to say that these investigations so altered our conception of the internal combustion engine and the fuel required for it that the first really significant advances in technology date from that time, and from these advances in technology went the possibility of designing the smooth-running, almost trouble-free apparatus which we now know as the modern automobile, and with the development of the automobile began the expansion of our industry. One could, if one wished, say that the use of kerosine as a heating and lighting medium, and fuel oil as a heating medium, would have increased even if there had been no automobile, but the enormous growth of our industry is unquestionably due to the development of the automobile and the aircraft engine.

The work of Sir Harry Ricardo showed that the highest useful compression ratio of a fuel in an engine was intimately bound up with the chemical composition of that fuel, and he brought out clearly the fact that the aromatic content of gasoline was of the highest importance. Up to that date gasoline had been judged on its gravity and volatility, but this work entirely reversed the ideas on the subject. His variable compression ratio engine in which gasolines of differing constitution could be tested was the forerunner of our well-known C.F.R. engine and whilst Sir Harry compared fuels on the purely scientific nomenclature of the highest useful compression ratio, the C.F.R. engine which was developed from it gave a more popular and perhaps more easily expressed figure in terms of octane. The *iso*octane, 2 : 2 : 4-trimethyl pentane, gave a very high useful compression ratio and was looked upon as the 100 per cent fuel, anything else being classed as having a percentage performance value of *iso*-octane.

Not wishing to labour this side of the work too much, I will now turn to the improvements in refining technology that went hand in hand with this new knowledge. The enormous growth in the requirements of gasoline during the First World War left the industry in the position that the quantity of gasoline produced by normal distillation methods from a given quantity of crude was totally inadequate to meet the needs of the market, and for some time there had been very considerable activity in the chemical engineering field in an endeavour to break down the heavier molecules of fuel oil into lighter molecules in the range required for the automobile and aircraft engine. During the years immediately following the First World War very many cracking units of several types were erected and it was found that what had been looked upon as a somewhat dangerous process because of the high pressures and temperatures involved could be made quite safe by developments in metallurgy and chemical engineering. The cracking plant became a common piece of refinery equipment, whilst the production of gasoline was thus increased to meet demand.

This simple state of affairs, however, was obviously not destined to last very long. A feature of the cracking processes was the production of very large volumes of gases, which were originally considered waste material and were burnt at field flares. Later a proportion of the gas was piped back to the refinery furnaces and boilers and burnt as fuel, but even so the production in most refineries was greater than could be used in this way. These gases on analysis were shown to be mainly olefins of the C_2, C_3 and C_4 types, obviously raw material for the manufacture of a whole range of pure chemicals in the solvent field, and in a very short time petroleum chemists became very concerned with the enormous wastage of such potentially valuable material.

Before touching on the chemical field, I should like to mention that the first step towards the economic use of these gases was plain polymerization of butylenes which, when passed over a catalyst such as phosphoric acid or sulphuric acid, gave a polymer in the C_8 range similar to *iso*octane and shown to be a very high octane gasoline suitable for blending with considerable advantage in the normal gasolines. One could enlarge on this to a considerable extent, showing the steps whereby one passed from the manufacture of cold acid polymers, hot acid polymers and the like, but I imagine that most of this history is well known to you and you would not wish me to go into any detail.

The processes were very successful, so successful indeed that it rapidly became necessary to find fresh sources of raw material in order to make the quantities of these polymers required for industry. As you know, the first discovery was the possibility of combining the paraffin *iso*butane with butylenes and the fact that any branched chain paraffin containing a tertiary carbon atom was found suitable for this type of combination, which became known as alkylation. This process was widely used during the Second World War for the manufacture of other materials besides paraffinic polymers, and the preparation of cumene and *iso*-butylbenzene was the direct result of this process.

Still there is not sufficient *iso*butane to satisfy the needs of the industry and the isomerization process, whereby normal butane was converted into *iso*-butane, was developed so as to make greater use of field gases and thereby to increase production.

Petroleum Chemicals

Now a word about the production of chemicals from petroleum. This is a recent and extremely important branch of the petroleum industry. The enormous industry of the aliphatics which has grown up is almost a branch of organic chemistry in itself and in many of these processes has given the direct lie to the classic organic chemistry taught 15 to 20 years ago. For example, the direct chlorination of olefins which takes place by substitution of hydrogen and not by addition across the double bond would have been considered quite impossible 15 years ago, and in fact I imagine any student who made such a suggestion in an examination paper would have been failed out of hand. Nevertheless, this development has been the basis for the synthetic manufacture of glycerine.

Apart from the interest to a chemist of this new branch of chemistry, one realizes the enormous importance to the world of a new source of solvents, plastics and a variety of materials which would have been very difficult to prepare had it not been for the large quantities of olefins made available by the cracking process.

Our industry is essentially, and I repeat essentially, an industry for the provision of a convenient form of power, and it is in this form that the bulk of the 400 million tons of crude oil is used annually. It is because of this very large

bulk of material processed that we are able to place at the disposal of the world such large quantities of this excellent starting point material for a chemical industry, but it must be realized that the chemical industry will always be of a very much smaller order of magnitude inasfar as tonnage is concerned than that part of the industry concerned in producing power.

I do not think I shall say any more about the chemical aspect of our industry, as it should really form a separate paper and if I were to attempt in a short space of time to give some impression of the developments along these lines I am afraid I should end up with a very boring catalogue of the materials which have been prepared and the uses to which they have been put. You will no doubt in the course of your lectures arrange for a series covering the uses of chemicals from petroleum, ranging from solvents to detergents, and the chemical engineers and chemists among you will no doubt find this aspect of our work contains much more of interest than many of the aspects of petroleum as a fuel and lubricant.

Lubricants

I shall now turn for a short time to the question of lubricants. In the lubricating oil field the greatest advance in the period under review was the development of the solvent extraction process whereby considerably larger areas of the world were opened up as possible suppliers of lubricants. Here again I do not think you would wish me to go into any detail of the various processes, or why it is that they have enabled us to use other crudes as raw materials. This is another subject which will no doubt form the basis for further discussions. But the problems connected with lubrication are of considerable interest. The fact that certain fractions of petroleum have the appropriate viscosities and the necessary stability towards oxidation, etc., in use has meant that they can be used for a wide variety of purposes, and it is an interesting but perhaps useless speculation to consider how much of the industrial development of the world has been due to the discovery of cheap lubricants for all purposes, such as these fractions of petroleum. Their use spreads into almost every field of human endeavour, from sewing machines to locomotives, from battleships to hair oil, from boot polish to caterpillar tractors, in fact it is almost impossible to think of any form of activity in which petroleum lubricants in some form or other are not in day-to-day use.

For a large number of these applications, lubricating oils, made from petroleum by suitable refining methods, give entirely satisfactory service. Petroleum oils are composed almost entirely of hydrocarbons and although a good deal can be done by modern refining methods to produce oils giving the best possible performance, there are cases where hydrocarbon lubricants alone are not entirely adequate. For example, in certain engines improved stability to oxidation at high temperatures may be necessary. In heavy duty diesel engines, freedom from excessive engine deposits requires that soot, etc., derived from incomplete combustion of the fuel should be kept in suspension in the oil. In certain heavily loaded gears, hydrocarbon lubricants alone are not adequate to prevent scoring.

As a result of these requirements, a large amount of work has been devoted over the last 15 to 20 years to the successful development of various additives to improve oxidation stability, wear characteristics and other properties. Some work has also been carried out on the preparation of synthetic lubricants, some derived from petroleum, others, such as silicones, of non-petroleum origin. While these may come into use for certain specialized applications, the difficulties of producing them in sufficient quantity and at a competitive

price are such that I feel sure that the great bulk of the lubricating oil used will be derived from petroleum for many years to come.

One perhaps feels a little at this stage that there has been so much development in the last quarter of a century that the subject is well-nigh exhausted, but to my mind the subject has really not been opened. I feel confident that production methods and refinery methods will be so entirely different in 25 years from now that they will be unrecognizable, and why?

There have been in the last few years notable developments which have profoundly affected our industry. These are the arrival of the gas turbine, the increased utilization of the diesel engine and the change in the whole economic outlook on fuel and power since the Second World War.

The Gas Turbine

Whilst a great deal of work was carried out during the 1930–40 decade on the gas turbine, it was again due to a war that the real developments were made. During a short period of five years in Britain we developed from a rather primitive tin-can combustion chamber into the jet engine, which is now already almost a commonplace. Whether these engines will be used in aircraft for civil purposes for some time to come is a moot point. There are so many psychological factors involved that one would hate to prophesy anything concerning the number of years it will take before the gas turbine is accepted. Furthermore, this method of propulsion is not the most economical, except in certain circumstances, and therefore it may be a long time before one sees the jet engine in general use in civil aviation. On the other hand, for military aircraft it has come to stay and is already in considerable production. In one form or another it will be the military engine of the future. I suggest that this again is a very suitable subject for further discussions if you can persuade someone to give you some more detail on the development and technicalities of the construction of the gas turbine for aircraft. There are many factors involved from the injection nozzle to the final transmission of power and I suggest it would be well worth your while to have one or two special sessions on these subjects. But it is clear from the point of view of our industry that the requirements of the fuel for the aircraft gas turbine are quite different from those of the high octane fuel which was required up to date.

The maximum pressures reached in gas turbines are far below those in the cylinders of reciprocating engines. Hence detonation does not occur and it is quite unnecessary for the fuel to have a high anti-knock value. Again high volatility is of less importance in a gas turbine fuel since carburation is not involved. These factors, together with the need for using the cheapest possible fuel, on account of the high fuel consumption of the gas turbine, have led to the use of kerosine type fuels. Considerations of supply may eventually lead to the use of fuels of somewhat wider boiling range.

It is important that a gas turbine fuel should burn cleanly and not form deposits of carbon on the combustion chamber, causing buckling of the latter. Some difficulties have been experienced owing to the flame blowing out at high altitudes. The flame should be relatively compact; too long a flame may lead to burning of the turbine blades. These factors, however, depend not only on the fuel but also on the design and operating conditions of the unit. Finally, since the gas turbine shows to greatest advantage at high altitudes, the fuel should have a low pour point and satisfactory viscosity at low temperatures.

Developments have been slower, but no less interesting, in the field of the gas turbine for land and marine purposes.

Such engines are in existence and my own company is proposing to instal one in one of their ships in the very near future. The engine is practically complete. The problems connected with the gas turbine for this purpose are, from the point of view of our industry, mainly due to the need to burn residual fuels, if possible. I shall return to this point later, but it is clearly in the interest of the world that the maximum advantage should be taken of petroleum fractions without too much work being expended on them, entailing cost in man-power and steel which throughout the world are at present in very short supply. The main problems that arise from the use of residual fuels are due to the presence in such fuels of ash-forming materials and sulphur compounds. The products of combustion from a gas turbine must all pass through the turbine with its narrow clearances and special construction, and anything in the nature of ash or corrosion due to sulphur might have quite a serious effects. Distillates can be used with considerable ease and if distillates were available in sufficient quantity the problem would be very much simpler. It would to a large extent be merely a problem of metallurgy.

The Diesel Engine

The use of diesel engines in automotive service has shown a spectacular expansion over the last 20 years or so, owing to the resulting economy in fuel cost, particularly in omnibus and truck operation. The diesel engine is coming more and more to the fore on account of its high efficiency and comparatively low fuel costs, which enable it to compare favourably as a prime mover for power generation, or for industrial or marine use, against steam raised in coal or oil-fired boilers. It compares favourably with the petrol engine also, by virtue of its capability of assuming peak load straight away from cold starting, the lower cost of the fuel used and its higher thermal efficiency which is roughly 32 per cent as compared with about 24 per cent for the petrol engine.

The same arguments, of course, apply to motive power units, and in particular the traffic on the railways should be tackled at once. A start has been made, and there are already a number of diesel locomotives in shunting operation, but main line service is still more or less experimental, the L.M.S. having only recently put in service the first main line diesel loco. No. 10000. Other countries, notably U.S.A., are far ahead of us in this respect.

In converting coal-burning steam locomotives to oil firing, only an elementary and not too economical a step has been taken, the advantage being, of course, only the usual one based on the difference in calorific value between a ton of coal and a ton of fuel oil; and while at the present time it has the additional advantage of coal saving, there are still incidental difficulties and the change is not really an economical one. A further step in economy will unquestionably be to the use of the direct-drive diesel locomotive, but this must be looked upon as much more of a long-term proposition. But even at present we cannot feel satisfied as long as we are using steam locomotives burning coal, when we know that so much better economy could be achieved by using the diesel-electric drive.

The Economic Use of Fuel and Power

Now a word on the general use of fuel. The world is at present facing probably the most serious crisis in its history. Apart from difficulties due to wars and the wastage which has taken place as the result of two wars, the world is now faced with a very serious economic crisis, not the least part of which is connected with the shortage of fuel and power. This shortage of fuel can, to a very large extent, be at present boiled down to a shortage of coal. If coal were available at present in Western Europe,

the wheels of industry in that area would once more begin to revolve and a considerable number of our problems would disappear almost immediately. With an industrious Europe, Britain would have very little fear of the catastrophe into which she is at present apparently plunging.

Why, as an oil man, do I say that coal is the secret of the problem? Nice as it would be to feel that our industry could come to the rescue at a time like this, one must remember that for a hundred years all the engineering equipment in Western Europe has been built up on, and designed for, the use of coal. It would, therefore, be quite impossible for a plain straightforward conversion from coal to oil scheme to be put in hand without enormous expenditure in steel and labour in order to convert the apparatus in which it was designed to burn oil.

But coal is scarce and is becoming more and more expensive to mine. Wages are rising and good seams are becoming exhausted. Even with all the added mechanization that one hopes for, coal prices will continue to rise and coal, I am afraid, will become more and more scarce.

This, one would say, is the golden opportunity for us to show what we can do with petroleum but, apart from the reasons I have given before, petroleum too is scarce. During the war many of us wondered what would happen to the tremendous amount of surplus equipment that was available after the enormous expansion in the programme for the manufacture of aviation gasoline. All of this equipment could not possibly be needed for the manufacture of automobile gasoline and possible uses for it were discussed. How wrong we were. In the United States of America as soon as the ban was lifted automobiles crowded on to the roads and everyone rushed to equip their houses with central heating based on petroleum fuel, with the astonishing result that in point of fact refinery equipment throughout the whole world is now the bottle-neck in the supply of petroleum products. In illustration of this I propose to give you a few figures showing the extraordinary and unexpected demands now being made on the petroleum industry in the U.S.A.—demands which now threaten to turn that country, hitherto the largest exporter of petroleum, into an importer.

The *total* demand for petroleum for the first nine months of 1947 has risen 10·4 per cent above the same period in 1946 due to the following causes:

Motor Gasoline.—There are more automobiles now than ever before, and they are largely old models and inefficient consumers. The registration is 3½ per cent higher than in 1941, the last pre-war year from the American point of view, but truck registration is up 34 per cent; and trucks, of course, consume more than cars. The overall increase is 18 per cent.

Kerosine.—Increased demand in 1947 compared to 1941, 46 per cent.

Domestic Burning Oils.—Up 68 per cent compared to 1941. The number of domestic central heating plants is expected to be 50 per cent higher than at the end of the war. Despite Government warnings of shortages, installations of oil furnaces were 17 per cent higher in August 1947 than ever before, and during the first 8 months of that year 790,000 oil burning furnaces were installed. The number for the same period of 1946 was 300,000.

Diesel Oil.—Purchases by the railroads during the first half of 1947 were 42 per cent higher than the first half of 1946, and 92 per cent of locomotives on order are diesel-powered.

Fuel Oil.—Overall rise in 1947 compared to 1941, 34 per cent. That used for electric power generation was 42 per cent higher and the demands for marine and industrial use were also considerably higher.

And so it goes on. The increased demand for all petroleum products *other* than those I have already mentioned

went up to 43 per cent more than in 1941. The total demand in the U.S.A. now is slightly above 6,000,000 barrels per day (approximately 1,000,000 tons per day) and the trend is still upwards; while the total refining capacity of the country is estimated at about 5,300,000 barrels per day, of which a small proportion cannot be utilized due to shortage of tankers to bring crude oil to the refineries.

The position is thus a race between the construction of refining capacity—hampered also by shortage of steel—and the rising demand rate. As there seems little hope of the construction overtaking demand, at least for some years, the U.S. are faced with having to make up the deficit by importing oil.

Whilst I do not want to bore you with too many figures, to complete the picture I would like to say a little regarding the world position as opposed to the sketch I have already given you of the largest oil-producing country.

Sources of energy are everywhere a vital requisite for economic recovery and for sustaining and developing the international economic structure. The three main sources of energy are coal, petroleum and hydro-electric power. If we give the production from each of these resources an arbitrary figure of 100 for the year 1920, then the corresponding figure for 1946 is:

Coal	107
Petroleum	395
Hydro-electric	350

Coal is therefore becoming relatively less important and petroleum and hydro-electric power are assuming a higher and more absolute importance. The figures just quoted are not, of course, comparable with one another, but only show the trend of rising demand. Reduced to terms of equivalent H.P. hours, a comparison of the relative amount of power available from the three sources would be:

	in 1920		in 1946
	%		%
Coal declining from	88·2	to	68·1
Petroleum rising from	9·4	to	26·3
Hydro-electric rising from	2·4	to	5·6
	100		100

Coal and petroleum are exhaustible. Water power is inexhaustible but depends on the concurrence of availability and suitable geographical features for its use. I leave you to draw your own conclusions.

Turning back now to petroleum, we are obviously thrown back on to an examination of the best use to which we can put such fuel as is available. I have already mentioned the advantages to be obtained by converting to diesel engines, both for the manufacture of electricity and for their use for locomotion. Furthermore, one has to consider quite seriously how far one can afford to continue making distillates when possibly residues could be used in the diesel engine. This quite naturally raises the point as to whether we are in fact using our raw material in the best way when manufacturing bitumen.

Under the same heading, one should consider the use of fuels for domestic purposes. In Britain alone we are using for domestic purposes about 30 million tons of coal directly, quite apart from that used for manufacturing electricity and gas. These two account for another 50 million tons, but I am not able to say how much of this electricity and gas is manufactured for domestic purposes.

And now a word on the general use of fuel.

There are many startling factors which make it obvious that some change is necessary if we are to use the fuels available to use for space heating efficiently. The Institute of Petroleum, in conjunction with the Ministry of Fuel and Power, recently carried out an investigation into this question and in a paper* written by Mr G. Richardson many startling comparisons are made between

* *J.P. Review*, 1947, 1, 241–54.

the efficiencies of various equipments for space heating.

Based on the original fuel burned, a few figures may be of interest. The ordinary electric fire, which is so widely used at present, gives us a fuel efficiency in the room of only 18 per cent, whilst the gas fire gives 29 per cent and our dear old coal fire 20 per cent. Compare these figures with even the anthracite stove of 55 per cent or central heating with a mechanical stoker giving 63 per cent and finally the despised kerosine heater which gives 93 per cent. The last-named has long been despised because of very inefficient bits of equipment which were put on the market in the earlier days and the fact that the operation of filling and starting up the apparatus was a smelly and disagreeable process. However, with modern equipment which can quite readily be made in many thousands, it is obvious that something should be done to improve our comfort with the aid of an apparatus that gives us 93 per cent efficiency and not by putting on the market large numbers of electric fires giving an efficiency of only 18 per cent.

Do you realize too that for water heating, the electric immersion heater, which has been made so popular of late, gives one an efficiency of only 12 per cent as against the kerosine-fired circulator giving 48 per cent, or a single point storage heater giving 75 per cent.

It is as well for you to keep some of these figures in mind. They are all to be found in the article referred to and what we should be considering *all* the time is not merely the simple question of conversion from coal to oil. That isn't even looking at the problem. The problem we should be helping everyone to solve is how to supply heat and power in the most convenient spot in the most economical way. Building a Bankside power station to take care of peak loads caused by too many electric toasters at breakfast-time is hardly the way.

Because, lastly, one must appreciate the fact that petroleum is being used on such an enormous scale now that the present production, and in particular the refining capacity, is totally inadequate to meet the needs. Reserves of crude apparently exist as the scene of activity shifts slowly from the United States to the Middle East where considerable quantities are available, but still refining capacity throughout the whole world is woefully short. It therefore behoves us as members of the petroleum industry to consider very carefully which way the future trends, and to ensure that anything we do and any plant we build is designed to provide us with products which will satisfy our needs over the next quarter of a century.

I hope I have made it clear that you, therefore, as the younger members of the Institute of Petroleum, have a tremendous future before you. You are in an industry which is providing a considerable amount of the world's power, and you have a duty to perform to see that this raw material petroleum which is at our disposal is used in the most efficient way possible. I would ask you to treat your subject very seriously and to consider all these points I have put before you very carefully and help in whatever position you are called upon to occupy, to make certain that posterity will not blame us for using up a most precious material, the supply of which, though large, is not unlimited.

TREATMENT OF WATER FOR MARINE BOILERS

B.S. 1170 : 1947 just issued by the British Standards Institute is intended as an introduction to water treatment for marine boilers. It describes that method of boiler water treatment by which the scale- and corrosion-forming salts are destroyed by alkaline reagents, with or without the use of an organic coagulant. Three methods are prescribed. The new standard is available from the B.S.I., 28 Victoria Street, London, S.W.1, price being 10*s.* 6*d.* post free.

ECONOMIC UTILIZATION OF FUEL OIL IN BOILER AND INDUSTRIAL FURNACES*

By ARNOLD PEARCE†

THE disastrous effects of the recent coal shortages on the whole economic life of Great Britain has brought home to many the significance of fuel in maintaining our standards of life.

In fact the whole structure of modern society as it is known to-day is dependent on an inexhaustible supply of power and heat in one form or another; it is also true that a nation's consumption of the utilities (gas, electricity, water, etc.) is an index of its standard of living and position in the civilized world.

While the next decade may bring about striking changes in the means employed for the production of power (i.e., atomic energy release, harnessing of the tides, solar energy, etc.), we can rest assured that modern society's prodigality in the consumption of power and heat for some time to come can only be met by the use of fuel in one form or another.

The discovery that large amounts of energy can be released in nuclear disintegration, culminating in the discovery of uranium fission and the atomic bomb, is considered by many to be the ultimate solution of all our energy problems. But we should not lose sight of the fact that none of the fissionable material known to-day exists in nature in anything but insignificant quantities, except probably U.235, which at the moment is both difficult and expensive to separate into material of the requisite purity.

Assuming all the problems of nuclear physics have already been solved theoretically and the aforementioned objection can be overcome by synthesis in a side reaction within the pile itself, we are still left with engineering problems of such magnitude as to defer for some time to come the application of nuclear energy industrially on anything like a big scale.

For the time being, therefore, we shall have to be content with dwindling fuel resources to provide us with the essential raw material for the production of power.

Largely as a result of the Second World War, coupled with big increases in the demand for the utilities, the shortage of primary fuels in combination with big reduction in quality and production and cost increases of the order of 100 to 200 per cent over the pre-war cost, is already having a serious effect on the economic life of Great Britain.

It is unfortunate, therefore, that an increasing percentage of our important industries is rapidly becoming dependent on an imported fuel, the supply of which may be seriously interrupted in times of stress. But since it is evident that shortage of solid fuels is going to remain with us for an indefinite period, it is hardly surprising that the situation has given a strong impetus to the conversion of plants from coal to oil burning whenever this is practicable.

A directive from the Ministry of Fuel and Power, on April 8, 1947, officially opened the campaign for expediting conversion of coal to oil burning plant, and it now appears that the annual rate of oil consumption may reach at least twice the amount consumed in pre-war years.

* Paper read before South Wales Branch, Institute of Petroleum, December 1947.

† Consulting engineer.

Although this consumption of oil represents only a small proportion of the consumption of solid fuels, its increased use in industry for highly specialized processes establishes its importance economically, and emphasizes the need for the most stringent economy in its use.

This paper is intended chiefly to discuss ways and means whereby economies in oil fuel consumption can be achieved, and to show what is being done in this respect in the oil industry, which is also a large consumer of fuel oil.

Oil refineries, however, form rather a special case since they sometimes have substantial quantities of waste fuels to dispose of and are not so obviously driven to obtain maximum economy in use of fuel. Nevertheless, in recent times great efforts are being made in this direction in order that the maximum amount of fuel can be made available to outside consumers.

Oil refineries consume large quantities of both steam and electric power, particularly where extensive processing of the oil is undertaken, and the probable gains by tying up steam and power are very attractive both from the angle of economy in fuel and in reducing overall operating costs.

OIL FUEL

General Properties

Fuel oil can be best described as a mixture of hydrocarbons of a comparatively low volatility, but varying in type. In general, therefore, the most frequently occurring series is the paraffin group, and the number of carbon atoms in the chain indicates the type of fuel. Thus, we may consider gaseous fuel having up to 4 carbon atoms in the chain and fuel oil up to about 25, and so on. The range of physical and chemical properties of fuel oil is thus a wide one.

One of the most important properties of a good fuel oil is that of chemical stability so that the large amount of handling and storage of the oil after leaving the refinery do not appreciably affect the properties of the oil prior to combustion. The fuel oil should not tend to cause carbonization in the system and precipitate sludge which may cause choking of the burner orifices and other operating difficulties.

Chemical stability has, however, little effect on combustion since most hydrocarbons in the fuel oil range burn equally well.

The specific gravity of the oil alone is no criterion of the quality and type of oil, though in fact at one time this was looked upon as a measure of fuel oil quality. It is not unusual, however, to find two fuels closely agreeing in gravity and yet widely different in performance when being burnt.

To give a true indication of the oil from the combustion standpoint it is desirable that other properties be known, and these, for convenience, are itemized below.

(1) Viscosity: the property of fuel oil which determines the ease with which it flows and can be atomized.

(2) Flash and ignition points: the temperatures at which oil gives off inflammable vapours and determines the facility with which the oil will ignite and burn.

(3) Pour Point: determines the point at which oil tends to solidify or congeal, and is, therefore, important if oil is to be stored in outdoor tanks.

(4) Carbon, water and sediment tests: affect burner performance, cause smoke, choking of orifices, erosion of surfaces and deposits on heating surfaces.

(5) Heating value of oil B.Th.U. /lb.

(6) Sulphur content: determines corrosive properties of flue gases at low temperature.

All these properties should be known to the purchaser who, in normal circumstances, would from time to time check these quantities.

A typical specification for Pool grades of fuel oil is given in Table I.

Combustion of Oil

Briefly, combustion involves the rapid union of carbon and hydrogen in the oil with oxygen in the air. Oil as a bulk liquid will not burn but, in the finely atomized state or in the gaseous phase, combustion is complete. The aim, therefore, of all atomizing devices is to produce such a fine spray that it approaches a vapour.

Again, to support combustion, the fuel must at least have a temperature approaching the ignition temperature of the oil. When burning heavy oils this is very important, not only from the point of view of maintaining ignition but also that the viscosity is kept within the range of the burners, say 100/170 sec Redwood, to suit the type of burner employed.

It is very necessary to remember that combustion of oil is accomplished in quite a different way from that of solid fuels. In the latter, air is directed through a bed of incandescent coke which is left after the volatiles have been distilled off at an earlier stage. The hot carbon reduces the CO_2 formed by contact with the coke to CO, which is then dealt with by the secondary air above the fire.

In the case of oil fuel, if the burner is correctly set with an adequate supply of air, the contact of oxygen with hydrocarbons in gaseous or atomized form produces, in the first place, the hydroxyl radicle OH, in consequence of which normal combustion can proceed. But where incorrect air supply is maintained and atomization is unsatisfactory, thermal decomposition or cracking of the oil spray is likely to occur, with resultant poor combustion and formation of soot deposits which tend to choke flues and boiler passes.

Actually, experimental evidence lends justification to the view that both extremes, i.e., hydroxylation and thermal decomposition, occur simultaneously in any oil flame. These two conditions of combustion are often seen in an oil flame which may on the one hand have a strong blue appearance, representing combustion in which preoxygenation takes place, or alternatively a yellow flame, with tendency to smoke, representing the other extreme of thermal decomposition.

In some industries, particularly the metallurgical, it may be desirable to operate as close to the yellow flame condition as possible (without giving

TABLE I

Property		* *Pool gas oil and diesel oil 100% distillate*	*Pool fuel oil*	*Pool heavy fuel oil*
Sp.gr. at 60° F.		0·840/·860 approx.	0·94 approx.	0·95/·96 approx.
Viscosity (Redwood I at 100° F), sec		32/45	220	950/1,500
Flash-point (closed), °F		150 min	150 min	150 min
Pour Point, °F		20 max	35 max	40 max
Ash, per cent		0·01	0·05	0·12
Water, per cent		0·05	0·5	1·0
Sulphur, per cent		1·0	2·75 max.	—
Gross Calorific Value, B.Th.U/lb		19,600/19,400	18,900	18,700
Other Information				
Pre-heat temperatures for use, °F	*Tank*	atmospheric	50	70
	Burners		120/140	180/230
Viscosity at burners approx. (Red I), sec		—	100/170	100/170

rise to excessive smoke), in order to obtain high flame emissivity, which is lacking when conditions approach hydroxylation. But more often in such cases the most important factor is the control of the furnace atmosphere to reduce oxydizing or other influences which might affect the quality and purity of the product.

The importance of obtaining the best possible combustion conditions is probably not always fully appreciated. The author had occasion recently to visit a large plant on the Continent where some of the boilers previously designed for pulverized fuel firing had been converted to oil firing. The fuel oil was a heavy oil with fairly high sulphur content and combustion was indifferent. As a result, it was estimated that due to corrosion the replacement of parts so affected involved about 150 tons of steel per annum.

(To be continued)

STANLOW BRANCH

AT a meeting of the Stanlow Branch held at Thornton on March 17, Brig. R. A. Bagnold, O.B.E., F.R.S., gave an illustrated lecture entitled "Wind-Blown Sand".

The lecture, which described the formation of sand dunes in arid deserts, was a most interesting variation from the usual type of paper presented at meetings of the Branch and gave an instructive picture of exploration and research in a field unconnected with the petroleum industry.

On March 31 M. Ingram, in a witty and well-informed talk, opened a discussion on "H.M. Customs and the Oil Industry". This was followed by a discussion on the controversial subject, "The Training of Laboratory Testers", which was ably introduced in a short talk by N. Cohen. At the conclusion of this meeting the chairman, H. E. F. Pracy, announced that he would be leaving Stanlow before the next meeting of the Branch and that the chair would be occupied in future by C. D. Brewer who has been elected chairman for the coming year. D. M. Glendinning, a founder member of the branch, expressed the feelings of all members of the branch in proposing a vote of thanks to Mr Pracy for his services during the three years in which he had been chairman of the branch, and this was received by prolonged acclamation.

Mr H. E. F. Pracy came to Stanlow four years ago and, among a variety of activities, took a leading part as a Member of the Committee of the Branch and was elected Chairman in 1945, succeeding the Founder Chairman J. S. Parker. He is leaving Stanlow to take up an appointment as Joint General Manager at Heysham refinery and will still be in the geographical area of the Stanlow Branch.

Mr E. Stokoe, who was a member of the committee of the branch, has now left Stanlow and we wish him success in his new appointment in Belgium. We also record the transfer of F. Brice to London. Mr Brice was honorary auditor of the branch for several years and rendered valued assistance to the committee on many occasions.

The final meeting of the current session was held at Thornton on April 21. Dr A. E. Dunstan was unable to lecture as originally arranged but kindly provided films which were shown on this occasion.

The 1948–49 session will open in October and it is proposed to hold ordinary meetings on the third Wednesday of each month. It is hoped that it will be possible to arrange additional meetings at which papers will be presented by members of the branch and the first Wednesday of each month will be an open date for this purpose.

SCOTTISH BRANCH

UNDER the Chairmanship of J. T. Guthrie, the Scottish Branch of the Institute of Petroleum held a meeting on March 26, 1948, in Edinburgh. The attendance numbered 60 and an address on "The Iranian Oilfields" was delivered by F. D. S. Richardson, M.A., (Geological Dept., Anglo-Iranian Oil Co. Ltd.), a synopsis of which follows:

In south-western Iran geological conditions have been exceptionally favourable not only for the generation of petroleum but also for its accumulation and its retention underground.

First, great thicknesses of highly organic marls, porous limestone and precipitated salts were successively deposited on the sea-floor, and these have respectively provided the petroleum itself, the reservoir in which it is now found and the impervious cover which has prevented its escape to the surface. At a later stage the strata were folded into anticlines and synclines of giant size and the marls and limestone were cracked through and through, enabling the petroleum to migrate freely from the marls into the limestone and from the synclines into the anticlines. The salty beds, on the other hand, accommodated themselves to the folding by plastic flow, and their effectiveness as cover-rocks was thus unimpaired.

The petroleum is stored both in the porous parts of the limestone-rock and in the joints and cracks which traverse it. The permeability of the rock is too low, even in the most porous zones, to allow direct feed into wells at high production-rates in the absence of cracks, and the wells draw their production from the larger joints which are themselves replenished by slow weeping of oil from the adjacent rock throughout their extent. These joints form a continuous network of channels in which fluid connexion is astonishingly free, so that small changes of pressure and of fluid-levels are quickly transmitted throughout an entire field. This is a matter of great practical importance, making it possible so to regulate output, adjusting the rate of withdrawal from each sector of a field to its observed productive capacity, that the fall in pressure shall be evenly distributed and local disturbance of fluid-levels avoided.

Fluid connexion through the synclinal areas is much less free, and as a result the extracted oil is only partly replaced by entry of water from outside the limits of the field, the remainder being replaced by gas released from solution in oil still in the reservoir. The gas-content of the oil is very high, and in consequence the flowing-life of wells is phenomenally long. Thus, although the Masjid-i-Sulaiman field has been on production for more than 35 years, the wells are still flowing without recourse to pumping.

At the conclusion of his address the lecturer answered in detail numerous questions. A vote of thanks to the lecturer was proposed by J. M. Caldwell and one to the Chairman by Robert Keddie.

UGANDA OIL SEARCH

WRITING on "The Geology and Mineral Deposits of Uganda,"* Dr K. A. Davies, O.B.E., and C. B. Bissett, director and deputy-director respectively of the Geological Survey of Uganda, say that petroleum is known to occur in the Kaiso and Kisegi beds of the Western Rift. From one hole drilled by a prospecting company in 1939, oil welled up slowly. Circumstances caused a premature closing down of the operations, but it is the intention of the Department to do scout-drilling to some 2000 ft. around the northern nose of Ruwenzori and on the Semliki and Kaiso plains.

* *Bull Imp. Inst.*, 1947, XL, 161–173.

THEN AND NOW

The first well to be drilled in the Turner Valley, Alberta, **(above)** *in 1914 was obviously an attraction to the populace. It certainly seems that it could be termed "a hole in the ground" while the headgear of the assistant driller is perhaps more fitting to the "man about town" of those days.*

To the right is seen a modern type of drilling outfit in this area which is regularly used for drilling or for reconditioning existing wells.

RESEARCH IN THE PETROLEUM INDUSTRY

THORNTON CENTRE OPENED

"THE petroleum industry completely accepts the essential value of scientific research at all stages—research not confined to the problems of oil alone, but keeping in touch with and utilizing the results of progress in many other spheres. Perhaps it is this characteristic of outlook, more than any other single factor, which accounts for the remarkable flexibility of the oil industry, and its expansion into so many fields of human activity.

[A Shell Photograph

Lt.-General J. H. Doolittle, K.C.M.G., speaking at the opening of Thornton Research Centre. Also seen (left to right) are Brig. R. A. Bagnold, O.B.E., F.R.S., Director of Research at Thornton, Mr George Legh-Jones, and Mr J. A. Oriel, C.B.E., General Manager of "Shell" Refining and Marketing Co. Ltd.

"One of the major results of these new and often revolutionary developments is that we are faced with an ever-increasing demand for petroleum, a demand far beyond pre-war anticipation, far beyond the world's present production of oil. Although that production is now greater than ever before, it still lags seriously behind urgent needs. And this is largely due to two other shortages—of steel for equipment, and of ships for transport," said Mr George Legh-Jones, managing director of the "Shell" Group, formally opening the Group's research laboratories at Thornton-le-Moors, Cheshire, on May 20.

"The Research Centre was a brain centre of the huge and rapidly increasing contribution which the petroleum industry was making in support of the British export drive. In it the seeds were being sown of a harvest which would yield millions of those dollars so much needed by Britain and Western Europe."

Concluding, Mr Legh-Jones paid a tribute to all concerned in the inception and operation of the Centre.

Lt.-Gen. J. H. Doolittle, K.C.M.G., director of Shell Union Oil Corpn., stressed the value of the research carried out at Thornton during the

[A Shell Photograph

One wing (the lubricating oil laboratory) of the Thornton Research Centre.

war and its contribution to the high performance of allied aircraft. There had been shortages of pilots, of mechanics, of aeroplanes, of bombs, of ammunition, but the operations of his command had never been halted for want of fuel, thanks to the petroleum industry.

Following the formal opening ceremony, the visitors were taken on a tour of the various sections of the Centre. When it is stated that, standing on a 30-acre site, the laboratories have a floor space of 730,000 sq. ft., some idea of their vast magnitude can be vizualized. In the various sections no less than seventy-eight engines of various types are housed, while there are rigs and appliances for small-scale work too numerous to count. Staff of the Centre numbers nearly 900, over 300 of whom are qualified technical staff engaged in research work, the Director of Research being Brig. R. A. Bagnold, F.R.S.

Motor Fuels

Among the problems under investigation in the motor gasoline division was the determination of the change in characteristics of the fuel during its passage from the carburettor to the cylinders, the object being to ensure even distribution and thus more effective use of the anti-knock component in the gasoline.

Many other matters were under examination, including such items as the nature of "running on", while cold chambers are available in which engine tests may be conducted at temperatures down to −60° C.

Diesel Fuel

While work is continuously in progress to ascertain to what extent present diesel fuels may be used more efficiently in existing engines, parallel work is also in hand to keep pace with new design trends and to relate this with fuel properties. Of particular importance is research on the use of heavier and more viscous fuels to release the gas-oil type to meet other demands.

Diesel fuels of low ignition quality are also under investigation in relation to the prevention of rough running in high-speed engines. Good results are being obtained with pilot injection, that is the injection of a small amount of fuel into the cylinder in advance of the main charge.

Lubricating Oil

In the laboratories devoted to the examination of problems relating to lubricants, spark and compression ignition engines are operated under conditions designed to accentuate the feature under study. Special rigs are also used to carry out research on gear lubrication and on special lubricants for metal rolling and drawing, for cutting, for steam cylinders, etc.

A Shell Photograph

In the new diesel fuel laboratory: single-cylinder injection pumps on test bench with oscilloscope recording needle lift.

Aviation Products

In the Aero Engine section special problems in both lubricants and fuels are dealt with, including the study of direct injection of gasoline into cylinders and ports. One important development at Thornton is the production of a coating to protect exhaust valves against the effect of leaded fuels. A feature of this section is a cold room

which can contain a full-size aero-engine and can be taken down to —40 C.

As may be expected, much work is being undertaken on the gas turbine. At the moment test methods are being developed for the rating of gas turbine fuels, and the many problems of ignition and combustion in this type of engine are receiving detailed attention. Investigations are also in progress into the utilization of heavier oils of the Bunker C type in marine gas turbines.

Chemical Products

The work of the Chemical Laboratory is mainly concerned with finding new uses for refinery products and by-products and with the production of industrial solvents and chemicals from petroleum.

Of particular interest is the pilot plant installation, which forms an intermediate step in the transfer of laboratory processes to the large-scale plant stage. Included in this section is a full-size plant for the production of complex organic chemicals, a pilot plant for manufacturing turbine oil additives, a thermal wax-cracking plant to study the production of olefins, highly efficient distillation columns, etc.

In order to facilitate the hook-up of apparatus for special tests an ingenious framework structure has been devised so that various items of chemical engineering plant can be rapidly assembled.

Of special interest among the new products demonstrated were a water emulsion paint (distemper) for inside use produced from the extract obtained in lubricating oil refining. Another interesting product was a perfume obtained by the conversion of an olefin to methyl heptyne compounds.

One of a Family

As Mr Legh-Jones said in his opening address, Thornton is the latest of the "Shell" network of research laboratories and is the youngest of a very distinguished family. Other members of this family are:

Amsterdam, Holland, the oldest of the "Shell" laboratories with a world-wide reputation for its knowledge of asphalt and many other subjects; *Delft, Holland*, noted particularly for research on diesel fuels and lubricants; *Emeryville, California*, concerned with the more fundamental work on oil products and the production of chemical products from petroleum; *Wood River, Illinois*, mainly occupied on product utilization; *Houston, Texas*, where problems in regard to exploration and production are considered; *Modesto, California*, where research on petroleum products for agricultural use is carried out on a farm station; *Woodstock, Kent*, where research on insecticides and agricultural products is in progress; and the Central Laboratories at *Fulham, London*, which are particularly concerned with product control.

BARYTES FROM THE EMPIRE

Enquiries were made for large Empire supplies of barytes for use in weighting oil-well drilling muds to replace supplies formerly obtained from hard currency areas, states the 1947 Annual Report of the Imperial Institute. Favourable replies were received from Australia, the Union of South Africa, India, Swaziland, Tanganyika, Kenya, and Eire and are being considered with a view to future action.

Bleaching Earth.—The bleaching earth from Cyprus referred to in the Annual Report for 1946 was found by tests to be superior to raw fuller's earth in its bleaching properties, and capable of some improvement by acid treatment, although it is not as good as commercial activated earths.

NORTHERN BRANCH DINNER

THE various Branches of the Institute of Petroleum were represented at the Northern Branch Dinner and Entertainment at the Grand Hotel, Manchester, on April 9, 1948.

In spring-like weather, guests and members began to arrive (minus umbrellas) at about 6 p.m., the guests including H. C. Tett (*Chairman of Council*), G. H. Thornley (*Deputy Chairman of Branches Committee*), W. J. Wilson (*Member of Council*), R. B. Southall and E. Thornton (*South Wales Branch*), W. Robert Guy (*Scottish Branch*), A. J. Goodfellow and N. E. F. Hitchcock (*London Branch*), and C. Chilvers (*Hon. Secretary*).

The Northern Branch around the festive board

Following dinner Mr E. J. Dunstan (*Chairman of the Northern Branch*) expressed the welcome of the Branch to their guests. Mr Tett, in a few well-chosen words, thanked the Northern Branch for their hospitality and his speech coincided with the time when the programme was marked "entertainment." Mr Tett's remarks certainly qualified under this heading for they gave much stimulus and "kept the party going."

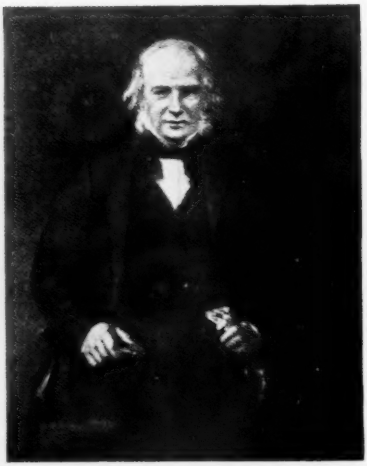
Speeches then gave place to entertainment with piano and vocal turns by Robbie and Platt, mystics by Oscar Paulson, patter and monologues by A. Kinsey, and odes by R. Redfern. Guests and artistes then occupied the interval by doing their "turns" at the buffet, following which there was more stage entertainment in which Messrs E. R. Wilson, K. O'Brien and D. W. O'Brien of the Northern Branch Musical Section ably assisted. The functions concluded with the Chairman proposing a vote of thanks to the artistes.

Mr Arthur Franks (left), Chairman of the Oil Distributors Emergency Council since its inception at the outbreak of the last war, receives his portrait in oils painted by James Gunn. The presentation, made by Mr A. Limb on behalf of all the companies associated with the Council, was to mark their appreciation of the valuable services rendered by Mr Franks.

JAMES YOUNG—FOUNDER OF THE MINERAL OIL INDUSTRY*

By EDWIN M. BAILEY (Member)

As future lectures will no doubt deal with the technical side of the Scottish shale oil industry and its origin and development, I propose to give only a brief outline of the work, in that particular field, of the remarkable man who was the founder of the mineral oil industry.



[Courtesy The Naft Magazine

Dr James Young of Kelly

In the year 1847, James Young, a chemist who was then manager of Tennant's Chemical Works in Manchester, examined a sample of mineral oil from a coal-mine in Derbyshire. He acquired this oil, about 300 gallons a day, and began to manufacture illuminating and lubricating oils from it. After two years the supply of oil failed, but Young, foreseeing this, had meanwhile discovered that coal, when heated in a closed retort to a moderate temperature, yielded a similar oil. In 1850 he patented his process and in 1851 began near Bathgate the manufacture of oil from a rich cannel coal, known as "Boghead Coal" or "Torbane Hill Mineral", that yielded from 110 to 120 gallons of crude oil per ton. In 1852 he obtained patent rights in the U.S.A. Both there and here at home these were disputed and infringed, but in litigation Young's claim was universally and emphatically held to be valid.

The Acting Commissioner of Patents for the U.S.A. in extending Young's patent for another seven years from 1864, said: "The manufactures of coal oil in this country had their origin in Mr Young's discovery. The use of *petroleum* followed so directly and obviously from the use of coal oils that it can hardly be denied that the one originated from the other. Previous to Mr Young's discovery, petroleum . . . had little or no commercial value. An invention which has contributed to such wonderful results can occupy no low place in public benefaction."

The British Law Reports of the trials in defence of his patent rights make most interesting reading, and one is impressed with the remarkable unanimity and vigour with which the verdict was in every case given in favour of Young.

In 1858, twenty-three American firms were making oil from coal by Young's patented process, and some took out licences from his representative on the spot, some paying 2 cents per gallon royalty. In 1860 he was three months in America. It was not until August 26, 1859, that Col C. L. Drake struck *petroleum* in his boring on Oil Creek, Pennsylvania.

* The James Young Memorial Lecture. Delivered to the Scottish Branch of the Institute of Petroleum, January 8, 1948.

As his patent covered not only the production of crude oil from bituminous coal by distillation "at a low red heat", but also the refining of the oil and the separation of the solid paraffin by cooling and filtration and its purification, to yield valuable commercial products, it is clear that Young was not only the founder of the Scottish shale oil industry, but also the originator of the great petroleum industry; he was the creator of the mineral oil industry.

After 1859, Young worked on the oil-shale found in the district of West Calder, where he later erected new works. In 1866 he sold his works and large trade business to "Young's Paraffin Light and Mineral Oil Company Ltd." *The Morning Journal* in February, 1866, stated that £450,000 was the price paid, Mr Young taking stock in the new company to the extent of one-fourth. He remained as General Manager with his son James assisting him till his retiral in 1870.

While on the Board of Directors of the new company, we learn from his dairies that he was reposing on no bed of roses:

Jan. 18, 1866. *A very disagreeable meeting.*
21. *Sunday at U.P. Church.*
29. *Meeting of directors. They came out in soft soder* (sic) *dodge, and all was confirmed.*
Feb. 26. *Moffat was as usual nasty.*
Mar. 16. *Meeting of directors—A little sense talked for the first time.*
April 1. *Long argument about building a place at Addiewell to make candles; the opposer Moffat.*
May 23. *Addiewell making candles with stearine.*
May 10, 1867. *Went to Edinburgh with Nicholson and had a row with Lawyers about railway money.*
11. *Telegram from Nicholson saying he had got the cash from Caledonian Rly.*
23. *Meeting in Glasgow of directors: got through some work, Moffat being absent.*
26. *Rogation Sunday. Midcalder Kirk.*
June 6. *Meeting of directors. Moffat absent so all quiet, and business done.*

The history of Young's manufacture of paraffin wax and candles is most interesting.

In March 1857 a London firm "manufactured and put on the market for the first time paraffine candles of English make." The price was 2*s.* 4*d.* per lb.

About 1867, J. C. and J. Field, of the Candle Works, London, published this letter in a contemporary newspaper:

". . . With reference to the sources of supply, while the oil wells of America may, in the future, furnish large supplies of solid paraffin, the quantity put on this market has hitherto been quite inconsiderable in comparison to that produced in Scotland from coal, under the patent of Mr James Young, of Glasgow, to whom the credit is due of being the first to produce and perfect . . . the now well-known paraffin oil, and from whose paraffin the candles on which Dr Letheby reports are mainly manufactured."

It is worth noting that Baron Reichenbach (a manufacturing chemist), in a paper published by him in 1854, said: "It is true that the *discovery* of paraffin is my own, and I have announced it. To Mr Young, however, belongs the merit of a *second* discovery, the merit of having elaborated a method which furnishes a comparatively large quantity of the substance, and which is sufficiently remunerative to the manufacturer—a result which I had vainly endeavoured to realize."

Reichenbach discovered solid paraffin (wax) in wood-tar and later found it in Burmese petroleum; and Christison, in Edinburgh, about the same time in 1831, found crystals of wax in Rangoon petroleum.

In a Statement by Miss Marion Thom, for which I am indebted to Professor W. M. Cumming, she refers to a "Specimen of the first solid paraffin made in Britain, about the year 1836, by Mr John Thom, one of Graham's students at the 'Andersonian'. He read a paper to the Andersonian Philosophical Society about 1837, and showed all Reichenbach's products. He made about 100 lb of the solid paraffin

throughout three years." The specimen was lent in 1947 by Prof Cumming to the Exhibition held at the Science Museum as part of the Centenary Celebrations of the Chemical Society.

Young at first manufactured only naphtha and lubricating oils; paraffin for burning and solid paraffin wax were not *sold* till 1856. The wax was produced before that date, but was wisely stored till large stocks were available for the market.

Besides candles, the wax was used instead of sulphur for tipping Bryant & May's matches; for water-proofing cloth and leather; for preserving meat by immersion in the molten wax; and in penny cakes in laundry work for imparting gloss.

In 1858, an advertisement by a *Wholesale Ironmongery Warehouse* offered "Young's Paraffin Oil Lamp, 4*s*., 30*s*.; Oil, 3*s*. 6*d*. per gallon. Paraffin Wax, 1*s*. 3*d*. per lb."

Leaving full details of a fascinating story, verified at first hand from all available original sources, to be related elsewhere, we may now consider Young's scientific and social activities in other fields, and I should like to present a true picture of a very great man—a greater and finer figure perhaps than we may hitherto have considered him to be.

In 1850, the year of his great historic Patent, he has in a note-book many notes of experiments on tungsten ore and chrome ore.

I may here point out that part authorship of *one* classical paper is frequently and *wrongly* attributed to James Young. The paper "On the Combined Action of Heat and Pressure upon the Paraffins" was really contributed by T. E. Thorpe, and *John* Young of the Andersonian University, Glasgow. (*Proc. Roy. Soc.*, Vol. 21, 187–23). "A Preliminary Notice on the Production of the Olefines from Paraffin by Distillation under Pressure", also by Thorpe and *John* Young, was published in *Proceedings of the Royal Society of London*, 1870–1, Vol. 19.

Young's connexion with the manufacture of chlorate of potash is not very clear.

This important manufacture was started in 1847 at St. Helens—at Muspratts' Works—and was described in detail by Jurisel in 1888, and in Lunge's "Sulphuric Acid and Alkali."

(1) "*The manufacture of chlorate of potash is a large and growing industry. Dr Young invented and carried into effect the method still in use.*" (Glasgow Herald, *May* 15, 1883.)

(2) "*While with Muspratt, Young discovered cheaper methods of producing chlorate of potash.*" (Chambers's Encyclopaedia.)

(3) *Chlorate of potash* "*was first manufactured on a comparatively large scale by Balmain and Parnell at St Helens in* 1847." (E. K. Muspratt, *J. Soc. chem. Ind.*, 29.7.86.)

(4) *In* 1883 *and* 1885 *there are patents by Muspratt for* "*improvements in the manufacture of chlorate of potash*", *and these may be based on earlier work by Young.*

(5) *In his note-book* ("James Young, Tennants, Manchester"), *he mentions* "*Stannate of soda; Red Prussiate; and Chlorate of Potash process and apparatus*".

In 1847 Young improved the manufacture of solid caustic soda, being the first to produce it by evaporating the solution in *cast-iron* pots instead of in silver vessels.

He also devised the process for making prussiate of potash by roasting horns and hoofs with potash on red-hot iron plates, the cyanogen from these organic nitrogen-containing materials combining with the potash and iron. The process was a most valuable one till superseded by the extraction of cyanide at gas-works.

It is interesting to note that the by-product carbon (known as "Prussiate Char.") from the process, accumulated at the works of the Hurlet and Campsie

Alum Works near Glasgow, was later found to be an excellent decolorizer for paraffin wax and was for many years employed for that purpose in the Scottish shale oil refineries.

In 1848 and 1849 Young obtained patents (Nos. 12359 and 12744) for the improvement in the manufacture of salts of tin for dyeing and printing purposes. It has been described as "an original and elegant process", and, like those of his teacher Graham, Young's methods were simple and effective.

When the horror of the potato disease in Ireland was causing suffering and death, a Committee was formed in 1845 in the Literary and Philosophical Society of Manchester to recommend the best means for its prevention. Young used very weak sulphuric acid, which was found to arrest the disease.

In 1858 he presented a paper to the Philosophical Society of Glasgow in explanation of his scheme for constructing a cast-iron tunnel, of 14 ft diameter, on the sea-bed between England and France, at a cost that he estimated at $3\frac{1}{2}$ million pounds sterling. *The Engineer* (Vol. V, 1858), gives an abstract of the paper. The construction and mode of working, as well as the materials —concentric tubes of cast-iron, the space between being filled with asphalt or other material impervious to water —were novel and ingenious, and difficulties had evidently been studied, as came out in the discussion of the paper, which was circulated in advance but never read or published.

The Patents, on various subjects, that I have been able to trace in the files of the Patent Office, number eleven, the dates ranging from 1841 to a posthumous one in the names of his trustees, taken out in 1883. There is also a joint patent in 1864, with A. C. Kirk, his engineer, for "improvements in motive-power engines".

Young's interest in scientific research continued unabated to the end of his life. In 1880 and 1881, along with Prof George Forbes, he continued experiments begun at Pitlochry in 1878, on the different velocities of white and coloured light. The results were published in the *Philosophical Transactions of the Royal Society of London*, 1882, Vol. 173, Part I.

(To be continued)

U.S. PETROLEUM REFINERIES

On January 1, 1947, the total crude-oil throughput capacity of the 399 refineries in the United States was 5,731,682 brl/day, compared with 562 with a daily throughput capacity of 4,860,194 brl on January 1, 1941, the date to which the last pre-war survey of the Bureau of Mines related. Thus, in the interim period there has been a remarkable increase in capacity of the average refinery from 8,648 barrels of crude daily in 1941 to 14,359 in 1947.

Data now available* shows that capacity operating on January 1, 1947, was 5,336,399 brl/day (4,180,588 on January 1, 1941), shut-down capacity was 233,083 brl (538,381 in 1941), and new capacity under construction 162,200 brl (141,225 in 1941).

Cracked Gasoline Capacity

In the same period the proportional rate of growth in capacity to produce cracked gasoline has been about double that of crude-oil capacity. On January 1, 1947, cracked gasoline capacity totalled 1,594,622 brl/day compared with 1,151,193 on January 1, 1941. Operating capacity on January 1, 1947 was 1,412,814 brl/day (1,021,006 in 1941), shut-down 101,808 brl (82,042 brl), and under construction 80,000 brl (48,145 brl).

* Bureau of Mines Information Circular 7455.

PETROLEUM IN PARLIAMENT

Austrian Oil

Asked on April 19 what proportion of oil products obtained from the Austrian oilfields are allowed to be used in Austria, the Secretary of State for Foreign Affairs said: About 337,811 metric tons of oil products from Austrian sources were made available for Austrian use in the year 1947. As my Hon. Friend is no doubt aware, all the Austrian oilfields are at present controlled by the Russians who do not make public any figures of oil production. I estimate that the proportion received by Austria is in the neighbourhood of 40 per cent of her production. This amount has not proved sufficient for Austria's needs and she had been compelled to import a further 15,401 tons of petroleum products during the past year.

Iraq Pipeline

The Secretary of State for the Colonies was asked (April 28) if he had any statement to make regarding a new pipeline from Iraq to Haifa. In reply he said that negotiations were in progress between the Palestine Government and the Iraq Petroleum Co. for permission to bring oil through their existing pipeline from the area covered by a concession recently granted them in Transjordan and from two new areas in Iraq.

Thanks to the Board

Replying to a question concerning the dissolution of the Petroleum Board, the Minister of Fuel and Power said on April 28: I take this opportunity to express the Government's appreciation of the great wartime services rendered by the petroleum industry and to thank all members and staff of the Petroleum Board for the valuable work they have done.

Coal-Oil Conversions

In an oral answer on May 6 the Minister of Fuel and Power said that the coal oil conversion programme was started in the spring of 1946, at a time when coal stocks were shrinking and there was plenty of fuel oil. By June, 1947, however, the oil supply position had changed radically and it was decided that no more conversion schemes could be authorized. By December, 1947, largely owing to the astonishing increase in American consumption, the world shortage had become more acute and it became necessary to defer the completion of unfinished schemes authorized earlier in the year.

Since then, there had been little improvement, while the closing of the Haifa refinery had created fresh difficulties. Accordingly, it will not be possible at present for all the postponed schemes to come into operation and, in the majority of cases, the firms concerned must continue to burn coal, probably for some considerable time to come. The only exceptions will be schemes of conversion which have exceptional economic merit, e.g., in certain cases of steel, glass and pottery production, where the actual process of converting to oil is nearly completed. The firms concerned will be notified shortly.

On May 11 the Minister, in a written reply, said that the total increase in deliveries of fuel oil for burning and power usage in the U.K. since January 1, 1947, had been approximately two million gallons. The greater part of this increase could be attributed to shortage of coal.

Symposium on Synthetic Lubricants. The report of the A.S.T.M. symposium presents the three papers which were read at the 1947 annual meeting, together with the discussion thereon. *Obtainable from the offices of the Institute, price 6s. 6d. post free.*

THE TRINIDAD BRANCH DINNER

THE Tenth Annual Dinner of the Trinidad Branch of the Institute of Petroleum was held at Port-of-Spain on April 10, 1948, Dr J. E. Smith, Chairman of the Branch, presiding. The guests included His Excellency the Governor (Sir John Shaw), the Colonial Secretary (Mr P. M. Renison), the Financial Secretary (Mr. A. R. W. Robertson), and a number of senior government officials and prominent business men.

Proposing the toast of "His Excellency the Governor," Dr J. E. Smith said that the Institute of Petroleum was an association of men mostly technical who foregathered at intervals to discuss subjects of interest to themselves and to the industry in general. On the occasion of the annual dinner, however, they met to renew the acquaintance of many friends and to tell them of the advances in the industry.

DEPTH THE SOLUTION

The present key-note seemed to be deeper and deeper, said Dr. Smith. Last year in Oklahoma a well reached 17,283 feet, one in Venezuela had gone to 15,106 feet, while the deepest well to date in Trinidad was 11,044 feet. Two others had exceeded 10,000 feet.

A number of the operators in the island were obtaining drilling outfits capable of drilling to below the 10,000-foot mark, and it would probably not be long before the present depth record was exceeded considerably.

This striving for depth was a logical outcome of local conditions as lateral exploration had not been very successful in developing new reserves.

Reserves are the life-blood of the industry and it is absolutely necessary to discover new underground reserves to replace the oil being produced daily from existing fields: Oil is a wasting asset. All the shallow prospects have been tested and most of them are now practically exhausted.

The average well in Trinidad is around 4000 feet in depth, and this will increase yearly. Production has been established in one field below 8000 feet. As lateral search is restricted by the limiting areal size of our oil province the logical step is to drill deeper and this phase of activity is of increasing importance.

World reserves are presently estimated at seventy thousand million barrels. Trinidad is estimated to have two hundred million barrels of this, or 1 350th. Reduced to an understandable scale, if the world reserve is represented by one quart, the Trinidad reserve would be about 66 drops.

Concluding, Dr Smith said that it was the endeavour of the industry to improve the reserve position, since it affected all future planning and governed the expenditure on facilities. Their hope was that the deeper drilling would uncover something. Deeper drilling was a development full of interest for the future of the industry in Trinidad.

His Excellency, replying to the toast, said he saw around him many friends in all walks of life, both inside the oil industry and outside of it. He was sure that those outside it had been invited, first, out of a sense of friendship and hospitality, and secondly, out of an inclination to tell them how little they really knew and understood about the oil industry.

THE STEEL PROBLEM

"The oil industry is suffering like other industries and like everybody else in the sterling area from the difficult economic situation in which the British Empire now finds itself and both its productivity and experimental programme are limited at the present time by the availability of steel, which is in extremely

short supply in the U.K., and by the scarcity of dollars. Steel is now, I understand from official information, available in even shorter supply than it was at the peak period of the war when the whole of the British steel industry was devoted to steel production, and I think you will need no further emphasis on that point to understand the extreme difficulty of the present situation.

"Moreover, during the war the oil industry enjoyed a very high priority for obvious reasons in the availability of steel production and supplies, which at the present time is somewhat diminished because the circumstances of the so-called peace in which we live are different from those of war. These things are unavoidable and inescapable in present circumstances. I know that many essential items of equipment are only obtainable from the United States and at the present time we simply have not got the dollars to pay for their requirements.

"I have been in communication with some of those gentlemen of the Colonial Office for some considerable time on the subject of the oil industry of Trinidad, which is vital to our economy, and to the Empire's economy—and I think I am correct in saying that Trinidad now is the only or nearly the only source of Empire oil—in order to obtain the maximum amount of dollar allocation to enable the oil industry to continue to play its vital part in the economy of the Colony and to continue with the exploration and development which are so essential if we are to maintain and increase our production. Although the result has not for the present been entirely up to our expectation I have reason to believe that the situation is understood and that everything possible is being done to enable these necessities to be met with the greatest possible speed; but it is not a question—as I said at the Chamber of Commerce luncheon —of mere caprice on the part of Government officials either in London or in Trinidad or of red tape or obstructionism or all the other phrases that are used when people speak of Government officials. It is simply *hard facts*.

"Owing to the sacrifice made by the British Empire during the war in order to win the war we have exhausted our foreign exchange and can only make it good by the heroic measures which you read about in the Press and in official publications. It is only by these measures and by the success of them that these conditions can be set right, which I have every hope they will be—gradually if not immediately—but I repeat that the importance of the oil industry of Trinidad to Trinidad, Britain and the sterling area at large are fully appreciated and understood and if you are short of equipment and supplies for the time being it is because there is absolutely no alternative.

"It would be superfluous to recite the importance in terms of statistics, of the oil industry to Trinidad. As you all know recent increases in royalties have been negotiated in London with the oil companies in consultation with the Colonial Office. With these recent increases, plus income tax and the wages paid to labour which also have recently been increased, the contribution of the oil industry to the revenue and to the overall economy of the Colony is, to use a very strong and unusual word, 'majestic'. I think we all fully realize this and it is unnecessary for me to emphasize it to a gathering of this sort to-night.

"At the present moment oil commands a remunerative price but this, I am advised, may not last for ever and the Colony's revenue in royalties is to some extent dependent on future development of world production. This is a factor of which the oil interests themselves are well aware but it is well that other persons within this room and outside of it should take carefully into account when they are considering the future of the Trinidad oil industry, and its effect on the general economy."

Other Industries

Mr L. A. Bushe, proposing the toast of "The Other Industries of Trinidad", said it was difficult to offer encouragement of substantial financial gain as a reward for their labours to the other industries at the present time. There were other inducements and he would mention two, the improvement of the standard of life of the community, and the thanks of the oil industry if they could assist that industry in its burden of providing the major portion of the money to run the Colony.

There were two industries which required immediate and considerable expansion—the tourist trade and shipping. The former needed greater amenities and the latter more and better ships. He was reminded that 30 years ago some shipping companies did not know where Trinidad was, as he was then given a steamship ticket from the U.K. to Jamaica, and a rail voucher from Jamaica to Trinidad.

Mr Eric Grell, President of the Trinidad Chamber of Commerce, in replying said that the oil industry had proved itself of great benefit to the Colony. They had heard that oil was a wasting asset but were consoled by the fact that the oil companies were showing their usual initiative and were extending their activities to marine drilling. All hoped that the oil deposits there will be as good as those on land.

The Guests

Mr W. N. Foster proposed the health of "Our Guests", and Mr P. M. Renison, the Colonial Secretary, replied. He said he was sure his fellow guests shared the awe with which he held his hosts. He had always been brought up to believe that oil magnates were the ultimate world powers (*laughter*), the only beings to whom even dictators paid respect, and that their hosts were the scientific wizards to whom even the magnates paid respect (*prolonged laughter*). On behalf of the guests he thanked the Trinidad Branch of the I.P. for its hospitality, its good company, and its eloquence.

APPLICATION OF LIQUID FUELS

What promises to be a fruitful Conference on the subject of "Modern Applications of Liquid Fuels" has been arranged conjointly by the Institute of Petroleum and the Institute of Fuel. The venue is Birmingham University and the period September 21–23, 1948.

The papers to be presented and discussed will broadly range over the whole gamut of liquid fuels from kerosine to heavy fuel oil. Thus, sessions will deal with the use of fuel oil in the steel industry, in the metal industries, in the glass and ceramic industries and in diesel engines for power generation and railway traction. The use of gas oil in gas manufacture will be a subject of one session which will also deal with the use of heavy fuel oil for the same purpose, while on the agricultural side the use of liquid fuels for the drying of grass, grain, malt and hops will be discussed. The combustion problems of the gas turbine will receive attention, and a special evening session on the use of liquid fuels for domestic heating will be held.

Membership of the Conference costs £2 2s. and pre-prints of the papers will be available at £1 1s. per set, which will include one copy of the final proceedings.

Full details are obtainable from the Institute of Fuel, 18, Devonshire Street, London, W.1, or from the Institute of Petroluem.

A MEMORIAL TO CHRISTOPHER DALLEY

MR R. R. TWEED writes that, during a recent visit to Trinidad, he was invited to attend an evening service at the Church of St Christopher, Siparia, Trinidad, an invitation which he accepted.

This church was being built at the time of the death of Christopher Dalley, who was well known to the workmen of Trinidad Petroleum Development Co. Ltd., and much appreciated for his genial, lovable, nature. Many of these men lived in Siparia village and it was decided to dedicate their church "To Mr Dalley's patron saint", as they expressed it.

St. Christopher's, Siparia, stands therefore, as a monument to our former President and as a measure of popular affection for him.

During Mr Tweed's visit he saw also a new housing scheme for workmen which is to be called Dalley Village, Siparia, so that in all probability the name of our Christopher Dalley will appear on future ordnance maps of the Island.

U.S. PETROLEUM INDUSTRY IN 1947

PRELIMINARY figures reported by the Bureau of Mines, U.S. Department of the Interior, show that production of crude petroleum in the U.S. during 1947 averaged 5,085,300 barrels daily, an increase of 7 per cent over the 1946 figure of 4,750,500 barrels.

Crude run to stills averaged 5,075,000 barrels daily for 1947, a gain of 335,000 barrels in comparison with the previous year. Stocks of refined products on hand on December 31, 1947, amounted to 267,103,000 barrels. These stocks were 4.8 million barrels less than at the end of 1946, the most significant change being a drop of 8.5 million barrels in the stocks of distillate fuel oil. Domestic demand was nearly 11 per cent higher in 1947 than in 1946, the main increases being distillate fuel oil 22.8 per cent, kerosine 15 per cent, motor fuel 8.1 per cent, and residual fuel oil 8 per cent. Details of production and demand are given in the accompanying table.

	1947	1946
	1000 *barrels*	
Production		
Crude petroleum	1,856,107	1,733,939
Natural gasoline, etc.	132,000	115,739
Benzol	690	2,070
	1,988,797	1,851,748
Imports		
Crude petroleum	97,532	86,066
Refined products	62,063	51,610
Exports		
Crude petroleum	46,117	42,436
Refined products	118,346	110,687
Domestic Demand		
Motor fuel	794,807	735,417
Kerosine	102,507	89,088
Distillate fuel oil	298,221	242,894
Residual fuel oil	518,394	480,029
Lubricating oil	36,513	34,891
Wax	2,477	2,271
Coke	10,082	9,029
Asphalt	47,250	43,253
Road oil	7,067	5,939
Still gas	85,564	88,136
Liquified gas	52,700	39,667
Other miscellaneous	4,722	6,287
Losses	28,666	15,885
	1,988,970	1,792 786

During 1947 the number of wells completed was 31,362, of which 18,307 were oil wells, 3,352 gas wells, and 9,730 dry holes. At the end of the year there were 4 522 wells being drilled.

NATIONAL Coal Board, Edinburgh. A vacancy exists in the Scottish Division for a man to carry out investigations into the control of naturally-occurring gas in underground workings. The candidate should possess qualifications in one or more of the following subjects: oil boring, coal mining, geology or ventilation, and have had underground experience. The post offers considerable scope for individual initiative. Salary within N.C.B. scales and in accordance with candidate's qualifications. Applications should be made to the Establishment Officer, National Coal Board, 1, Eglington Crescent, Edinburgh, 12, within seven days.

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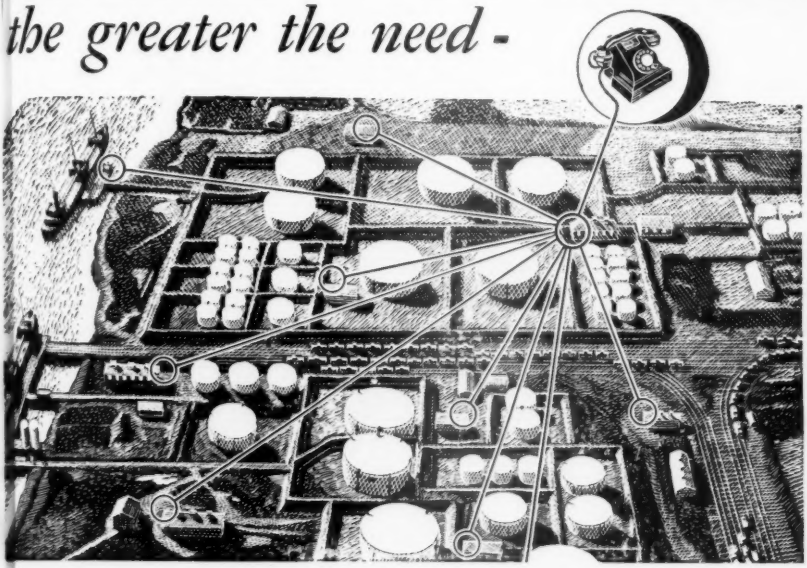

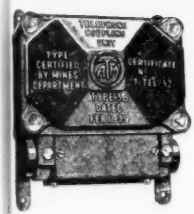
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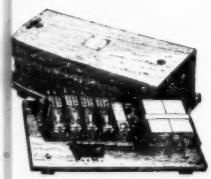

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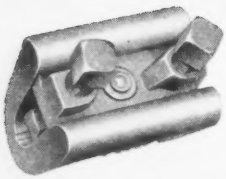

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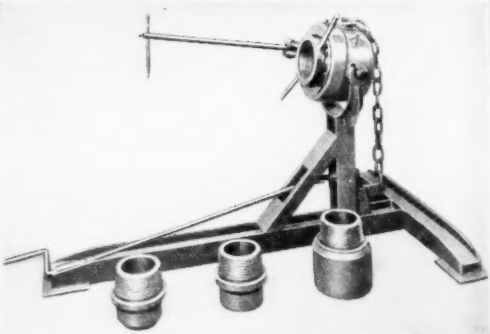

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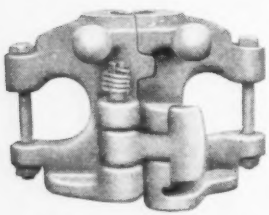

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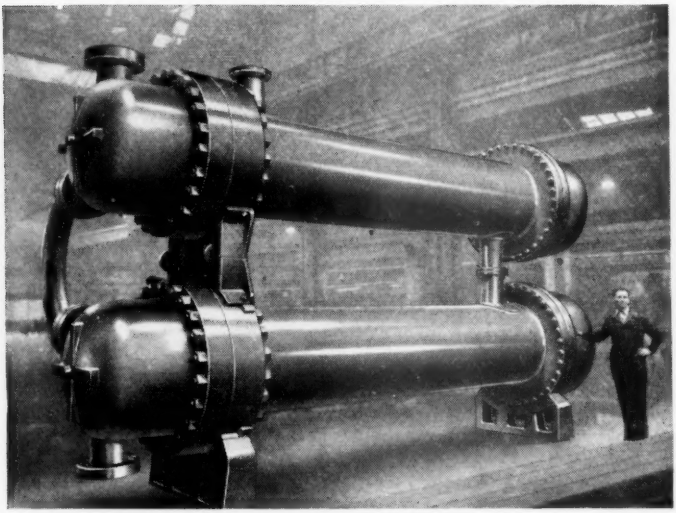

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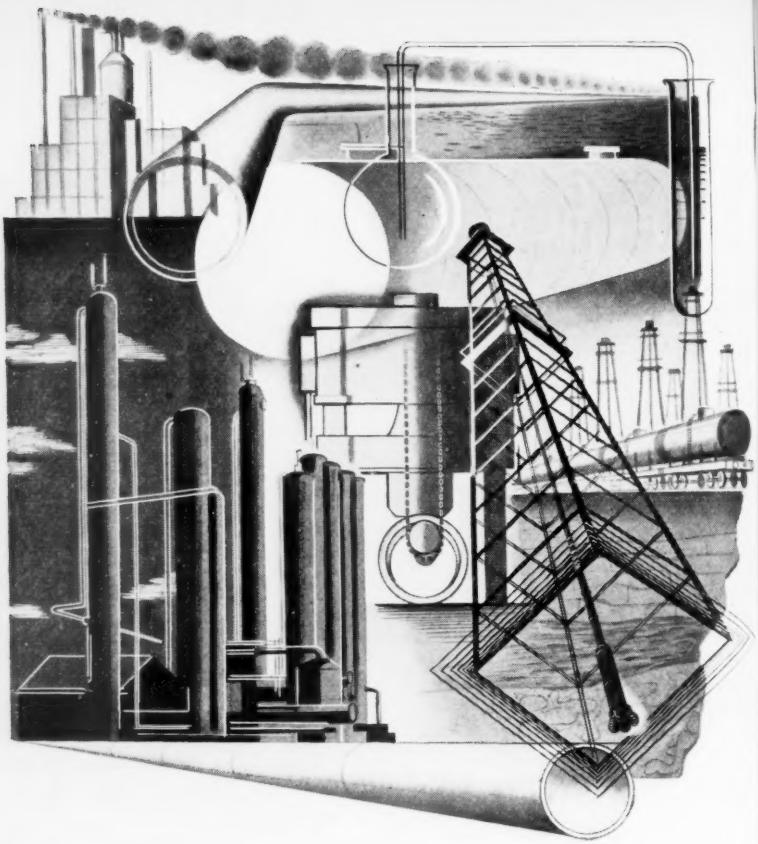

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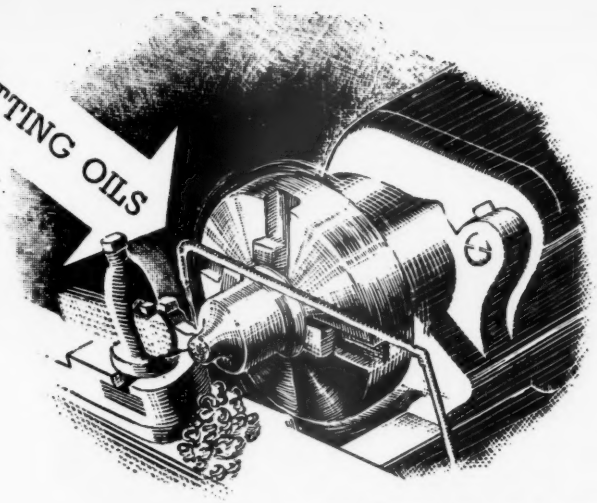

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